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TECHNOLOGY BULLETIN

Cellular Tendon

Customer Benefits

- Enables use of TLPs to 3,000 m water depth
- Provides an alternative surface facility for TTRs in Ultra-Deep Waters
- Applicable for Large displacement TLPs in any water depth
- Increased structural redundancy compared to conventional tendons
- Less critical welding requirements means more options for fabrication
- Installation does not require high hook HLV

Introduction

Tension Leg Platforms (TLP) have been the favorable choice for deep-water field development, specifically where drilling, workover, SCRs, and/or dry-tree completion with top-tension risers are hosted on the FPU. Currently there are over a dozen TLPs installed in regions including the GOM, Southeast Asia, and West Africa. Furthermore, several TLPs are currently in various stages of design and fabrication, for installation in the GOM, West Africa and Brazil in the near future. For a TLP in ultra-deep water, the technical and commercial practicality is mainly determined and governed by those of the tendon system. The application of TLPs faces technical and economical limits for water depths beyond 1,500 meters, due to limitations of the conventional tendon system. Also, the cost of conventional tendon installation in certain regions is sometimes prohibitive for the commercial viability of the project.

The Cellular Tendon technology is an enabling technology for TLPs to meet the industry's demands for producing oil and gas in ultra-deep waters to 3,000m. The cellular tendon technology shows clear advantage for ultra-deepwater FPUs for a large range of throughputs/ payloads in ultra-deep water depths. This technology mainly relies on proven industry products for tendon components, and existing industry practices to construct and install the Cellular Tendons.

Image courtesy SONAMET

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Cellular Tendon Design enables TLPs to meet the industry's demands for producing oil and gas in ultra-deep waters beyond 1,500m and supporting topsides with large payload/throughput.

Advantages

- Utilizes qualified existing products and proven industry practices to provide sufficient vertical and lateral stiffness while maintaining efficient resistance to tension-collapse in the ultra-deep water
- Has high flexibility to accommodate wide range of topside payloads with displacements from 50,000 ton to 150,000 ton
- Higher level of structural redundancy in the tendon main body thanks to the multiple-string construction for both the towing / installation and in-place conditions
- Enhanced local fabricability. The design can accommodate less stringent S-N curves
- Material cost savings from small hull size , omitting mechanical couplings, and Installation cost savings from not needing heavy lift vessels

Limitations of Current Non-Ship Shaped Floaters

	TLP	Spar	SEMI
Fabrication	○	○	○
Quayside Integration	○	●	○
Transportation vertically	○	●	○
Available deck area and wellbay size for large quantity of TTRs	○	◐	○
Heave response for TTR application	○	○	●
Tensioner type suitability for harsh environment	○	◐	◐
Suitability for HP and /or Sour service large size SCR	○	○	◐
Suitability for ultra-deepwater dry tree application WD > 1,600 m (5200 ft)	●	○	○

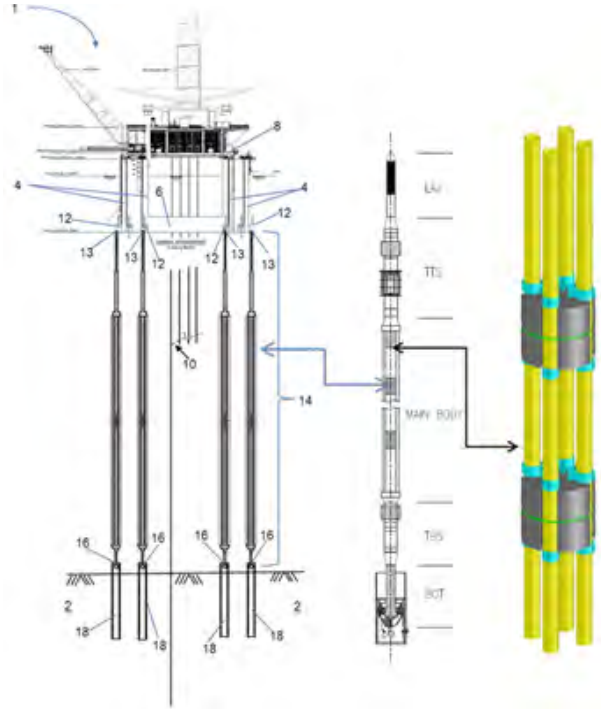
○ No Major issues

◐ Major issues that can probably be resolved with additional engineering analysis and cost

● Major issues that may not have a foreseeable solution.

Cellular Tendon is developed to resolve the issue in ● for TLP

Cellular Tendon Configurations



Comparison of Conventional Tendons vs. Cellular Tendon

	Conventional Tendon	Cellular Tendon
Design	Single pipe main body with TTS and TBS	Multiple cell pipe main body with TTS and TBS
Connection Between Pipes	Coupling	Girth Weld
Construction	In segments 200 ~300 ft (60~90m)	String near total tendon length, assembled on-shore
Transportation	Transported in grillage to site	Towed to site
Installation	HLV lift and assemble piece by piece, stab-in and latch to foundation	Upended, pulled in and latch to foundation
Pre-service	Supported by TSB	Supported by TSB
Connect to TLP	Guided and latch into tendon porch, Deballast TLP to apply tendon pretension	Guided and latch into tendon porch, Deballast TLP to apply tendon pretension

Publications

OTC Brasil 2013-24305: MS Cellular Tendon[1] - Enabling Technology for Ultra-Deep
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